Questions for Structures FOSS Kit – Plants and Seeds Section – July 2007
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Hydroponics

1.) Why do we grow our crops in soil instead of using hydroponics?

It depends on the conditions - we do both. Hydroponics are often used in greenhouse conditions or areas that are very arid or have little to no soil (e.g. deserts, areas with permafrost, volcanic islands, space stations). Actually, one of the largest hydroponics operations in the world is in Wilcox, Arizona (tomatoes).

2.) Why does the FOSS kit use water culture method instead of aggregate culture method?

I was a little unclear here as to what the aggregate culture method is. There is an “expanded clay aggregate method” along with many others used in hydroponics culture. Basically, there are (many) different mediums used for different approaches to hydroponics. The 2 general approaches are 1) solution culture in which there is no solid medium, only a nutrient solution and 2) medium culture in which any number of solid mediums are used (sand, gravel, vermiculite, etc.) to support the plant’s root system.

My guess would be the FOSS kit uses solution culture for reasons of simplicity.

3.) If a plant is grown hydroponically, can it be transplanted to soil successfully?

Yes – this would be little different than transplanting a house plant, especially one that you rooted a cutting in water. There could be more “transplant shock” though due to the plants roots never having been in contact with the soil mixture you use for transplanting.

4.) Are bush beans the fastest germinating seed? We'd like the fastest for the lessons.

I do not know. BUT, a simple experiment would answer this question. ;~} 

5.) How tall will a bean plant grow in 8 weeks using hydroponics?

- I do not know, but it would depend on the nutrients, light, and water available. Again, this is a perfect opportunity to run an experiment.
6.) Why was hydroponics first investigated?

As mentioned, it is useful in areas of low quality soil or low water availability. Like any greenhouse conditions, many variables can be controlled such as the amount of light (they can “lengthen” the day with artificial lights), better pest and disease control, and the precise amounts of nutrients made available. This can allow for high productivity and yield of crops and a faster harvest turnaround.

In soil farming, the plant is essentially killed when it is picked from the plant or plucked from the ground. With hydroponics the plant (e.g., lettuce) can be transported to market alive. There are many advantages and disadvantages, and proponents and opponents to hydroponics.

7.) If you had a choice of soil or hydrocultures what would be the preferred method for growing plants?

It would depend on the species of plants being cultivated. Some crops such as grain (wheat, corn, rice, etc.) wouldn’t be suitable for hydroculture due to the vast quantities that are produced for mass consumption. Some vegetables that are grown for a specialty market (e.g., hydroponic, organic lettuce or tomatoes) lend themselves to smaller scale hydroculture. And, if you are on a space station, you have no choice but to use hydroculture.

8.) Are there any natural differences in plants that aren’t grown in soil?

By this I assume, “Do hydroponic plants mature differently from plants grown in soil?”

I think it is safe to assume that the plants grow essentially the same. There are likely minor differences in actual root growth since the roots grow free of soil. But in the end you have the same plant regardless of growth medium. And, by manipulating conditions (e.g., light, nutrients, pest control) you can get the plant to reach maturity in a shorter amount of time.

**Seeds, Fruits, and Plants**

1.) Why aren't all seeds edible (e.g., apple, orange)?

It depends on how the plant evolved to reproduce (it’s “life-history strategy”) and have it’s seeds dispersed and propagated and/or what seed dispersers (animals) evolved with it. Often, as we discussed in class, the seed needs to pass through a digestive track unharmed. The fleshy, sweet parts of many fruits are intended to attract animals
(including human animals) that will eat the flesh but then pass (most) of the seeds. This works to disperse the seeds to a new locality, away from the parent plant. Additionally, the seeds are “dropped” with a bit of starter fertilizer. Most seeds are edible to something (mammal, bird, insect, etc.).

2.) Considering the seeds of annuals and perennials, what is the genetic difference and how can this be explained?

Each species of plant has its own genetic code, with closely related plants having similar genetic codes (e.g., we share between 96% - 99% of our genetic code with chimpanzees). Perennial and annual plants are employing 2 different life history strategies. In perennial plants (generalized), energy is expended to establish a persistent root stock that allows them to survive over the years (≥ 2 years), including times of harsh conditions (e.g., drought). In stressful years perennial plants may produce very little or no seeds, but this particular strategy allows them to “wait out the hard times for better days.”

Annual plants, in general, are able to respond quickly to optimal growing conditions (think about all the “weeds” coming up in your yard this monsoon season!); they grow fast and (often) produce many seeds and then die. These seeds last in the soil until next growing season (of course many of these get eaten, rot, or diseased) when they will again take quick advantage of good growing conditions. It is 2 different approaches to the ultimate challenge for all species: survival and reproduction.

3.) Why do some fruits have more seeds than others?

Again, these are different life history strategies that evolved for reproduction and survival (i.e., in to the next generation) in any given species. For example, some seeds are wind dispersed (e.g., cottonwood, willow trees) so the chances of any one seed landing in a good place for growing is slim. So, cottonwoods and willows produce many thousands of seeds per plant. On the other side of the spectrum, some plants may put most of they’re energy in to producing a few, highly viable seeds that have a high chance of getting dispersed to an area optimal for germination.

An analog in the animal world would be comparing elephant to mice reproduction. Elephants invest a lot of time and energy to produce one offspring every 5 years or so while mice are capable of having several relatively large litters within a single year. Again, these are different strategies to survival and reproduction.

4.) How long can a seed lie dormant?

It depends on the species. Small, soft seeds (e.g. cottonwood tree seeds) may not persist long at all in the environment due to deterioration or being eaten. Some seeds with particularly hard seed coats can lie dormant for many, many years, especially if conditions are optimal. In fact, the Texas sophora and coral bean (2 common perennial, landscape plants in this region that have bright orange-red seeds), will NOT germinate UNTIL they have been in/on the soil for many years.

5.) How are seedless fruits developed?

Seedless fruits are developed in 2 ways. Some plants will produce fruit even when the flowers have not been pollinated. Without fertilization, seeds will not form. In some cases the flowers may be pollinated but the seed development process is aborted and mature seeds do not form. For example, “seedless” watermelons actually have seeds, they are just infertile (accomplished by cross-breeding 2 different genetic strains of the watermelon plant). That is why you can see them usually as tiny, soft, white flecks in the watermelon meat rather than the large, dark, and not-so-soft seeds in regular watermelons (the latter being the ones that are so fun to have seed spitting fights with!).

6.) How do vegetables with no seeds grow?

Seedless fruits and vegetables are grown by grafting onto a stock plant or from cuttings that can be rooted, stuck in the ground, and then essentially grow as a clone of the original plant. One problem with cultivating plants with this method is that large fields become essentially all clones and therefore have very little resistance to disease or pests. If a disease comes through that can affect one plant, it can affect them all causing mass crop failure.

7.) Why do you want to eliminate the natural seed production?

Seedless fruits are driven purely by the consumer market. Some people find seeds in their oranges, lemons, watermelons, etc. a nuisance and so seedless fruit were developed. Personally, I prefer my fruit with seeds in them (see the watermelon comment above)

8.) How do you breed plants in captivity to produce seeds out of a fruit – (i.e., apples/oranges)?

This would be similar to any seed collecting procedure. My guess is certain growers are simply in the business of “growing seed,” rather than producing, e.g., apples and oranges for consumption. They would harvest the fruits and then extract the seeds (likely mechanically) for sale as seed.
But, a key issue with the 2 fruits mentioned (and many others), apples and oranges, is that most commercial citrus and apple orchards are propagated by grafting. That is, a hardy stock tree has branches from other types of apple varieties grafted into them (not unlike a skin graft). That is why it is possible to have a single apple tree with several different varieties hanging from its branches.

9.) Why are some vegetables called fruits (i.e., what is the difference)?

The term vegetable is a culinary term rather than a scientific, botanical term and as such is subjective. The technical definition of a fruit is the ripened ovary and it’s contents (e.g., seeds) along with any other floral or vegetative parts which might be attached and which mature along with it (e.g., you can still see the sepals from the flower on a blueberry – the star shaped tip). So, any “vegetable” that fits that simple definition is, in botanical terms, a fruit. Examples of some vegetables that DO NOT fit that definition are those in which we eat the stems (celery, rhubarb, asparagus), the flower heads (broccoli, cauliflower), leaves (lettuce) and lateral or terminal buds (brussel sprouts, cabbage, respectively).

10.) Pineapple—fruit or seed?

Pineapple is the fruit of a tropical bromeliad (you may have some bromeliads as houseplants). Commercial pineapple has been bred to have miniscule to non-existent seeds (similar to a commercial bananas).

11.) Why do a strawberry and pineapple fall into the category of an aggregate fruit?

Technically pineapples are aggregate fruits, which in turn are a type of compound fruits. They develop from a single flower with multiple ovaries that fuse together as the fruit matures. Technically strawberries are NOT compound fruits but a special kind of fruit known as an accessory fruit. That is, the fleshy part is derived not from the ovaries (those are the "seeds" on the outside) but from other, non-ovary tissue. So from a technical standpoint, the seeds are the actual fruits of the strawberry plant.

If the FOSS kit groups them as aggregate, it is incorrect BUT when you start getting into all the different types of fruits and how they are formed it starts to get complicated.

12.) What are the essential nutrients plants need to grow?

- Primary: Non-mineral = Hydrogen, Oxygen and Carbon
- Primary: Mineral = Nitrogen, Phosphorous and Potassium
- There are many others, see: http://en.wikipedia.org/wiki/Plant_nutrition
13.) How do plants get nutrients, and how is this different from making food?

Plant’s absorb mineral nutrients from soil and water through their root system and absorb non-mineral nutrients through their leaves. These nutrients, through the process of photosynthesis, are then used to produce food for plant growth, maturation, and seed production.

14.) Do any plants have vertical stems?

I was unclear on this question. I thought maybe this meant to say “horizontal stems” as most plants we are used to have vertical stems. Some plants do have horizontal stems that lie on the ground turning upwards near the ends (termed – “decumbent stems”).

15.) What purpose do weeds serve? (grazing?)

Weed is a subjective term (non-botanical) used to describe plants that are generally undesirable to the observer. They can be either native or non-native species to an area and generally share the traits of being vigorous growers and reproducers. Also, they often grow well in disturbed areas (yards, gardens, old fields, etc.)

The “purpose” of weeds is in the eye of the beholder. Many “weeds” are useful as livestock feed while others are actually toxic to them. One common “weed” that grows in Tucson yards and fields is amaranth, a plant that has edible seeds and leaves and was utilized by Native Americans in this region and other parts of the world.

An example of invasive exotic weeds include buffel grass (imported as livestock range feed) and fountain grass (used as a common ornamental grass in Tucson). Both have escaped to the natural environment and are out-competing many native species, thus causing change to the natural ecosystem.

Ideas for Class:

**Collect dried seed pods or seeds from the many seed producing trees in your neighborhood, focusing on native species (e.g., Palo Verde, Mesquite, Acacias, Coral Bean). Use these to illustrate wild seeds / fruits versus the common table vegetables and fruits used in the kit. Also, once you start breaking into the various pods, you discover that seeds come in a beautiful variety of colors, shapes, patterns and sizes. Students could glue the different native seeds and label them in their notebooks, thus starting a seed collection.**
**Search various University Agricultural Extension Cooperatives for information on plants, insects, water, etc. That is what these services are there for; public outreach and to answer questions.**

University of Arizona Cooperative Extension:  
http://cals.arizona.edu/extension/